 Document 10

Petreski, Sonya

From:	James Lindley <James.Lindley@aemo.com.au>
Sent:	Thursday, 26 March 2020 6:10 PM
To:	Chan, David
Cc:	Gannon, Rob; Babak Badrzadeh
Subject:	RE: West Murray Zone solar farm voltage control issues [SEC=OFFICIAL:Sensitive] [ACCC-ACCCANDAER.FID1813251]
Attachments:	ESIG-High Share of IBGTF.pptx

Hello David,

Attached is an updated presentation developed by Babak Badrzadeh, originally presented at ESIG Fall Workshop in October 2019. It addresses both aspects of "understand the underlying phenomena of the issues, and what is being done to correct this issue".

Kind regards,

James

From: James Lindley
Sent: Thursday, 19 March 2020 22:20
To: Chan, David <david.chan@aer.gov.au>
Cc: Gannon, Rob <Rob.Gannon@aer.gov.au>; Babak Badrzadeh <Babak.Badrzadeh@aemo.com.au>
Subject: RE: West Murray Zone solar farm voltage control issues [SEC=OFFICIAL:Sensitive] [ACCC-ACCCANDAER.FID1813251]

Hello David,

Thanks for the conversation today, and I can confirm that we will pull the requested information together for you. Hopefully we can get this done in the next few days (we are a but under the pump at the moment) – if it will take longer we will let you know.

Kind regards

James

From: Chan, David <david.chan@aer.gov.au>
Sent: Thursday, 19 March 2020 15:44
To: James Lindley <James.Lindley@aemo.com.au>
Cc: Gannon, Rob <Rob.Gannon@aer.gov.au>
Subject: West Murray Zone solar farm voltage control issues [SEC=OFFICIAL:Sensitive] [ACCC-ACCCANDAER.FID1813251]

OFFICIAL:Sensitive

James
I would appreciate if you can provide us an update on the main causes of the voltage fluctuation problems.

This information will help us in:

- [redacted]
- To inform the AER Board on this matter.

Regards
David Chan
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Practical example of assessing and mitigating issues associated with operation of inverter-based generation in Australian National Electricity Market

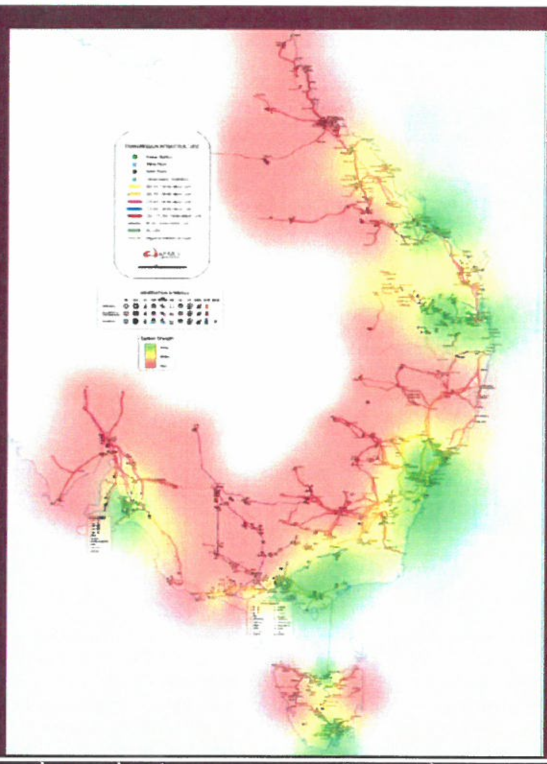
Babak Badrzadeh
Australian Energy Market Operator

Problem statement

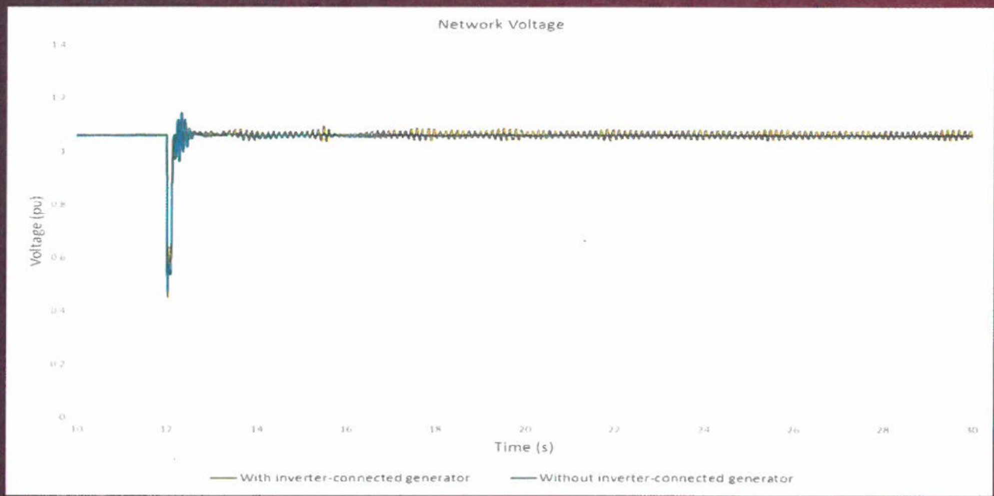
Inverter-based generator connection sparsity

- Far from capable synchronous generators
- Close to other inverter-based generation

Lack of system strength is one of the key challenges



The need to design generating plant capable of operating in such networks



Sustained post-disturbance sub-synchronous oscillations

- Oscillations unacceptable due to:
  - Breach of system security and flicker requirements
  - Impact on load/connected equipment

Appropriate simulation tools

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EMT vs RMS models

- AEMO has developed full-scale EMT models of all five South Eastern regions that it operates to assess:
  - High penetration of inverter-based generators
  - Lack of system strength
- EMT models were not available at the time of assessing respective connection applications

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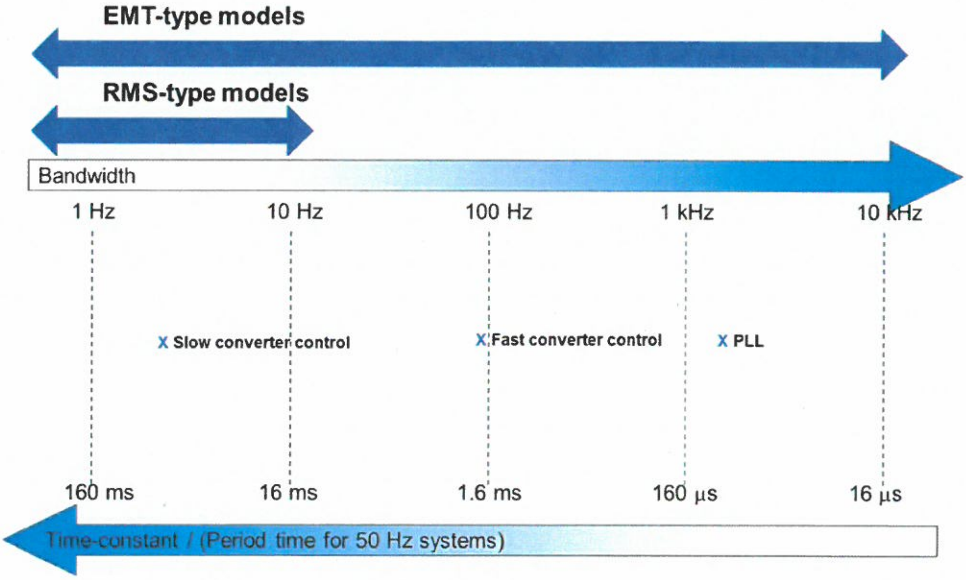

RMS models are not suitable for assessing sub- or super-synchronous oscillations

Withstand capability of inverter-based generators to lack of system strength

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Basic definition of short circuit ratio

- Inverter-based generators are designed to withstand down to a certain level of system strength.
- This is often characterised by short circuit ratio (and its variations), sometimes combined by X/R ratio.
- This withstand capability depends on the response of inverter control system

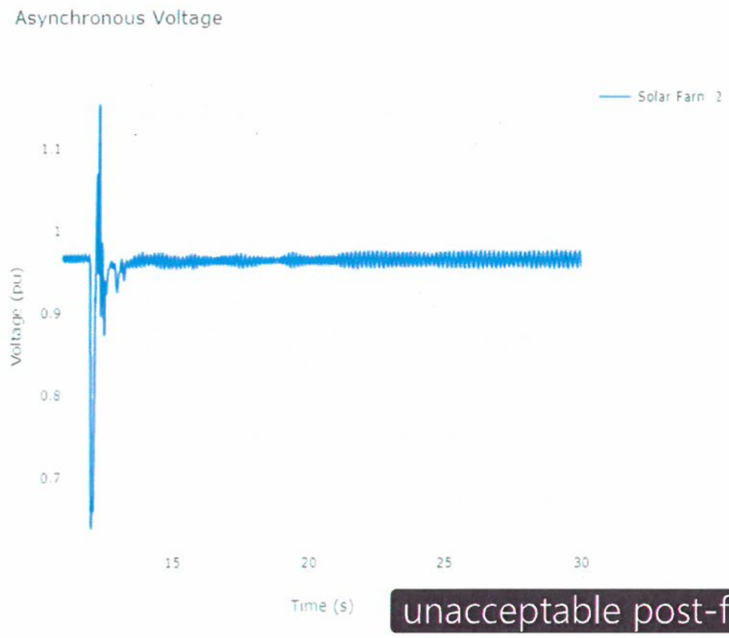
- Definition of short circuit ratio

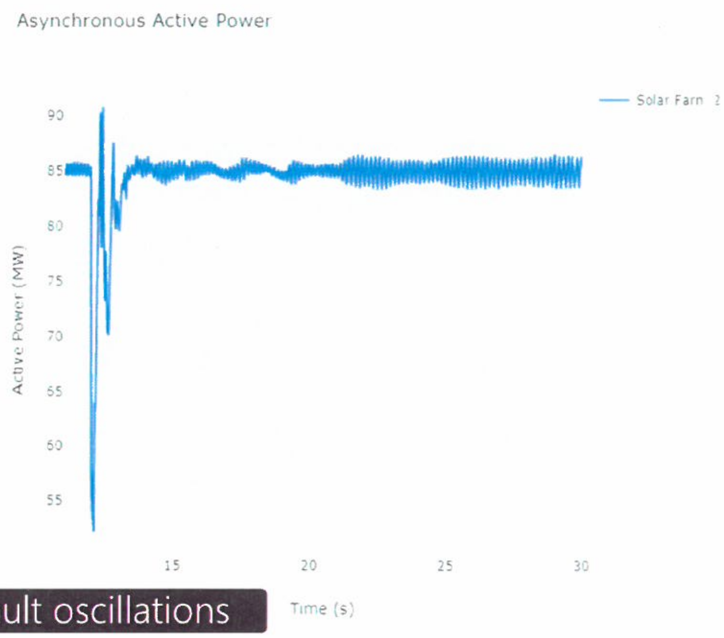
$$SCR_{POI} = \frac{\text{fault } MVA_{POI}}{P_{RAT}}$$

$$SCR_{POI} = \frac{\text{fault } MVA_{POI}}{S_{RAT}}$$

Example of sustained post-disturbance oscillations

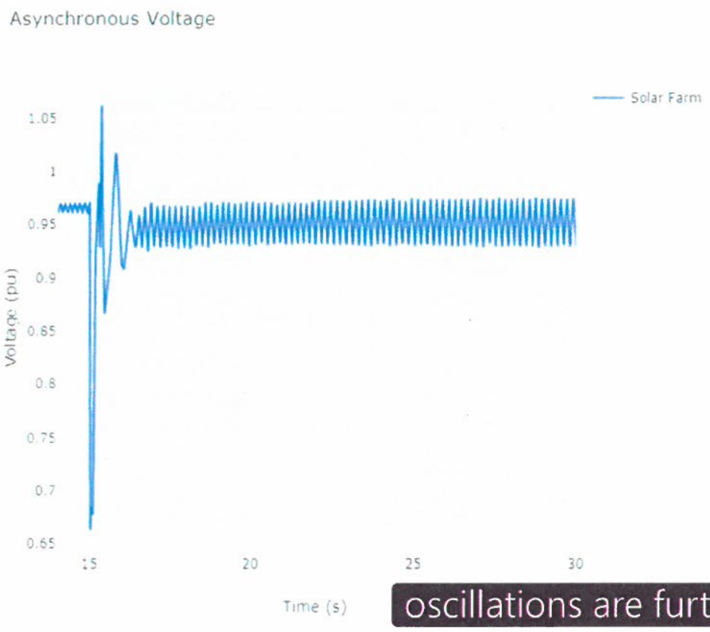
All solar inverters and SVCs are in service

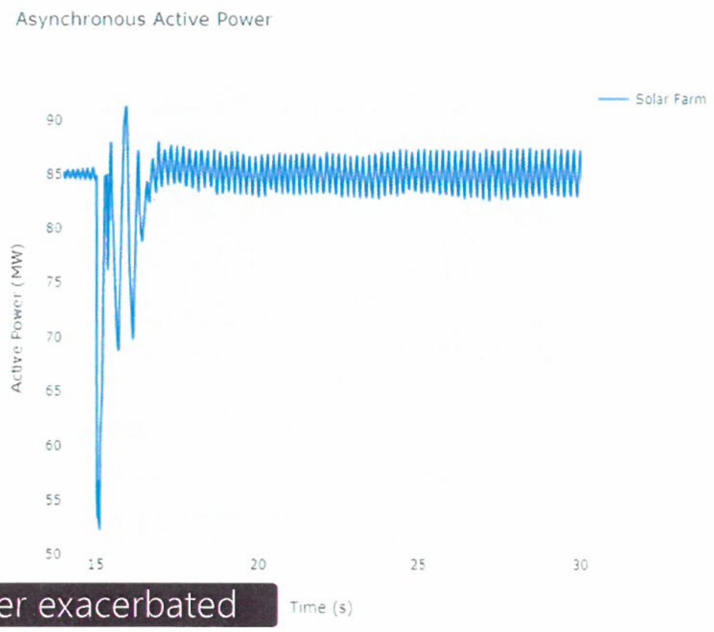




unacceptable post-fault oscillations

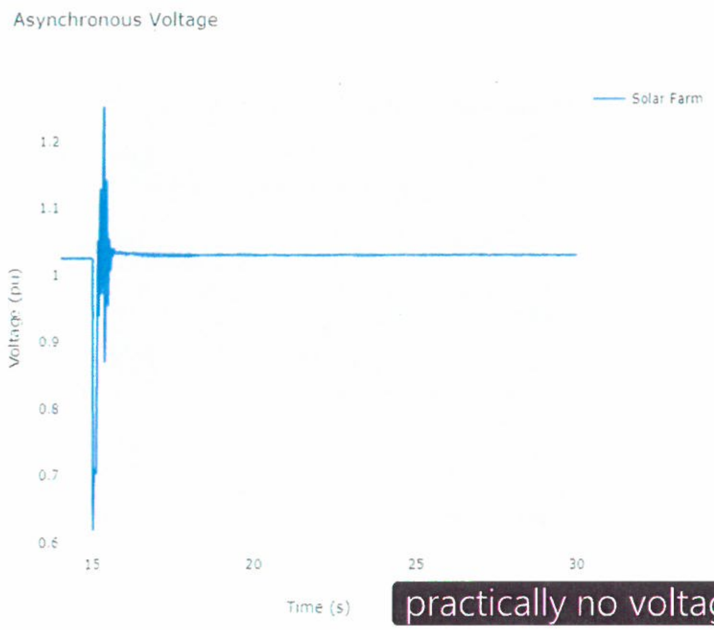
All solar inverters are in service with all SVCs out of service

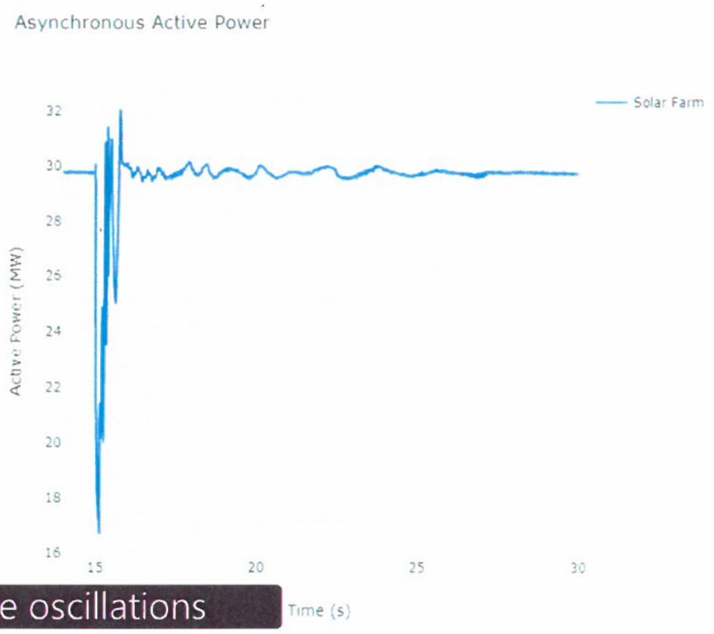




oscillations are further exacerbated

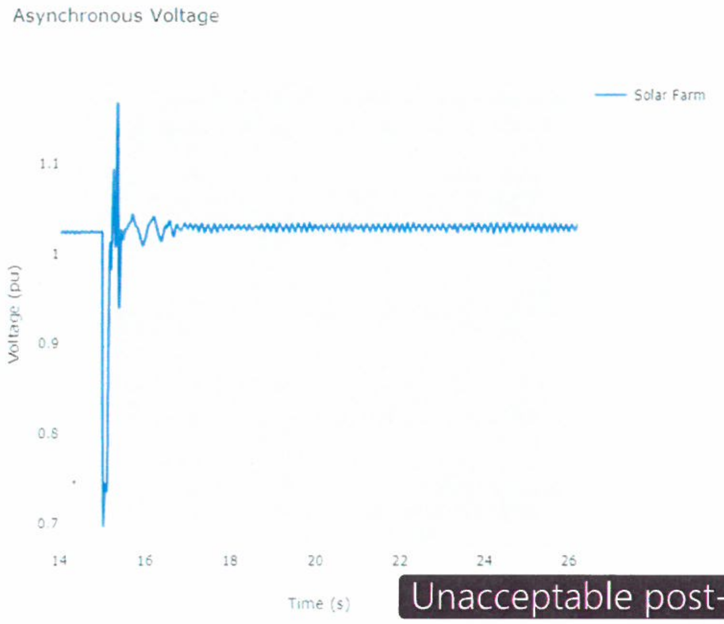
35% of inverters are in service

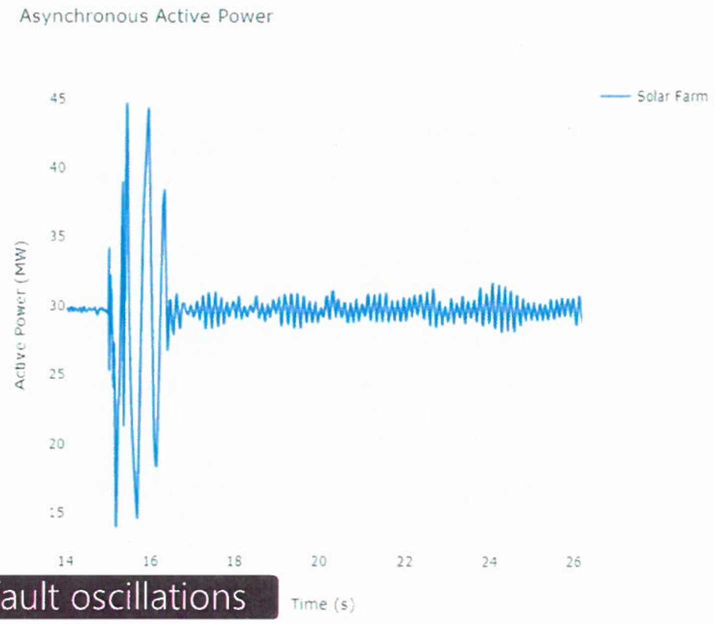




practically no voltage oscillations

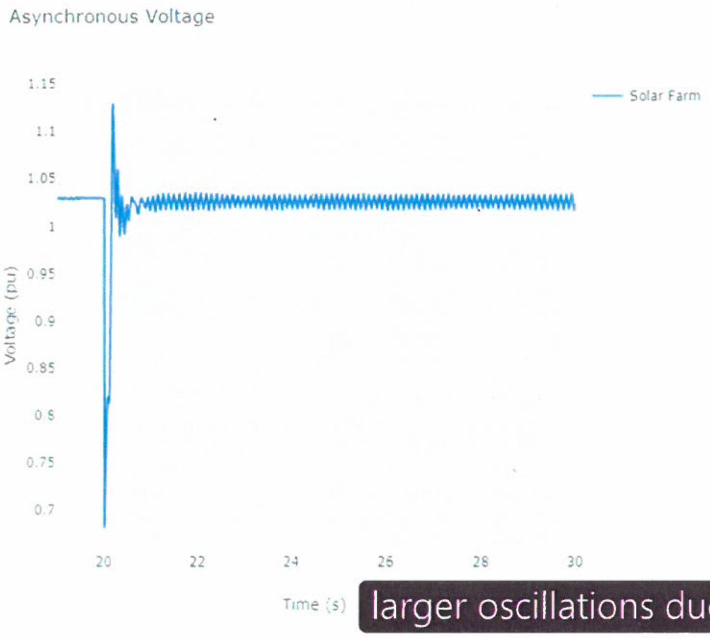
All inverters are in service but dispatched at 35% of nominal power

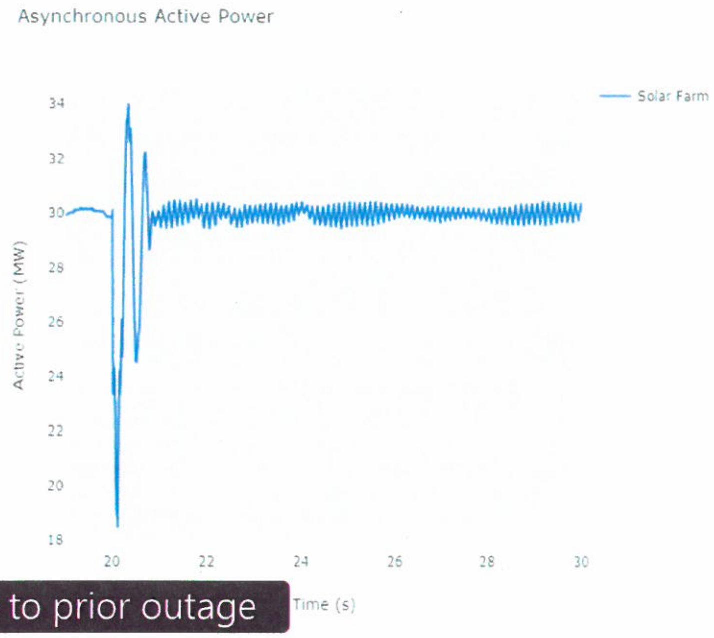




Unacceptable post-fault oscillations

35% of solar inverters are in service with a prior network line outage

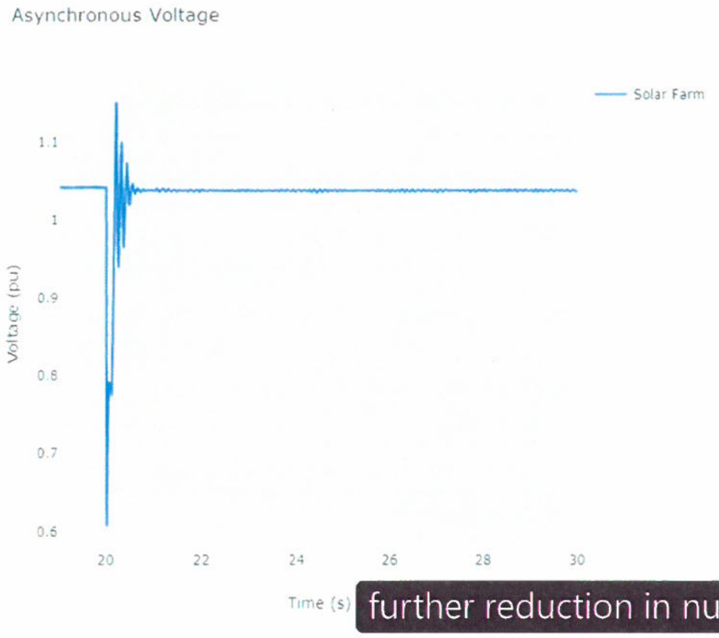


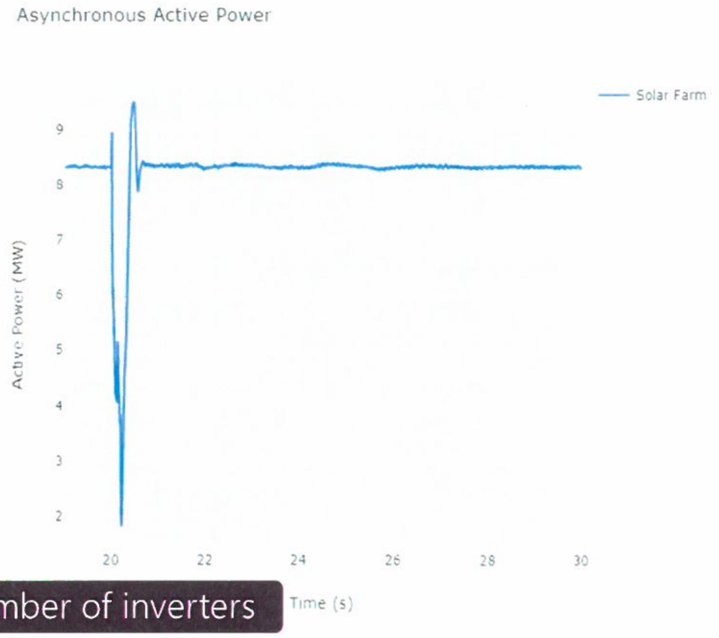


larger oscillations due to prior outage

Released under FOI

10% of solar inverters are in service with a prior transmission line outage





further reduction in number of inverters

Mitigation measures

Temporary constraints

- A reduced number of inverters limits the oscillations within acceptable levels (currently applied)

Inverter control system/parameter changes

- Retuning the control parameters or refining the control strategy of the impacted inverters limits the oscillations within acceptable levels or removes the oscillations altogether (being finalised)

Installation of nearby synchronous machines

- Installation of nearby synchronous machines increases the system strength available to the inverters in a remote and sparse part of the network (installation of network synchronous condensers following system strength shortfall declaration)

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